VIVEKANANDA GLOBAL UNIVERSITY, JAIPUR

SYNOPSIS

Name of Scholar: Sarita Boolchandani

Provisional Registration number:

Title of the Research Investigation: Preparation & characterization of chalcogenide compounds thin films for electronic industry.

Faculty/Department/Subject: Electronics & Communication

Objective and Scope of the Research Investigation

- To develop a thin-film with chalcogenides compounds by using an atmospheric pressure chemical vapor deposition by vacuum coating unit.

- To observe the changes occurs in properties (like Electrical, Optical, Thermal etc.) by changing the doping concentration of materials.

Proposed Methodology

Thermal Evaporation (Vacuum Coating Unit)

Thermal evaporation is one of the most widely used techniques of physical vapor deposition (PVD). It is a type of thin film deposition, which is a vacuum process wherein coatings of pure materials are applied over the surface of many different objects. The deposited coatings or films usually have a thickness in the range of angstroms to microns and are composed of a single material or layers of multiple materials. The coating materials can be either molecules, including nitrides and oxides, or pure atomic elements such as both metals and non-metals. The object to be coated is called the substrate, which can be many different things, including semiconductor wafers, optical components, and solar cells.

Thermal evaporation is a process wherein a solid material is heated inside a high vacuum chamber to a temperature which generates some vapor pressure. Inside the vacuum, even a very low vapor pressure is adequate to create a vapor cloud within the chamber. This evaporated material now consists of a vapor stream, which passes through the chamber, and strikes and sticks onto the substrate as a film or coating. Since, in a majority of cases, the material becomes liquid by heating it to its melting temperature, it is normally placed in the bottom of the chamber, often in some form of upright crucible. The vapor then rises above

from this bottom source and reaches the substrates that are held inverted in suitable fixtures at the top of the chamber, with surfaces to be coated facing down toward the rising vapor to acquire their coating.

Various measures may have to be taken in order to ensure film adhesion and control different film properties as desired. The evaporation system design allows process engineers to adjust a number of parameters to obtain desired results for variables such as grain structure, uniformity, thickness, stress, adhesion strength, optical or electrical properties, and much more.

Heat Source

Two heat sources are predominantly used for heating the source material, namely the filament source and the electron beam (e-beam) source. The method that uses the filament source is called as filament evaporation, wherein the heat source is a simple electrical resistive heat element or filament. There many different physical configurations available for these filaments, including the 'boats,' which are basically thin sheet metal pieces of appropriate high temperature metals like tungsten with formed indentations or troughs to place the material. The filament source provides the safety of low voltage, but requires very high current, typically in the range of several hundred amps.

The method that uses the e-beam as heat source is referred as e beam evaporation. It is a sophisticated technique to heat up a material and involves some risky high voltage (normally 10,000 volts). Hence, extra safety features are always incorporated into the e-beam systems. The source itself is an e-beam 'gun,' where electrons are boiled off by a tiny and very hot filament, followed by subsequent acceleration by the high voltage to create an electron beam with substantial energy. This beam is magnetically directed into the chamber and heats the material contained in a hearth that is cooled down by water to avoid its own destruction. These commercially available e-beam guns have multiple crucibles and can hold many different materials simultaneously, thus allowing easy switching between materials for multi layer processing.

Importance of Proposed Research Investigation/ Expected outcome

The thermoelectric junction designed will be characterized for different parameters such as current, voltage, temperature. By this research the best junction will be selected among the chalcogenide compounds.

Review of the work:

R. Roy, V. S. Choudhary, M. K. Patra, A. Pandya [1] in their work studied the electrical and optical properties of as-grown and annealed films of selenium, grown on glass substrate by thermal evaporation technique at room temperature. The structural characterization was carried out by taking XRD pattern of the films.

A.A. Al-Ghamdi [2] studied the optical constants (absorption coefficient (a), refractive index (n), extinction coefficient (k), real and imaginary part of dielectric constant) for SeTeAg thin films as a function of photon energy in the wavelength range (500–1000 nm). It has been found

that the optical band gap increases while n and k decreases on incorporation of Ag in Se–Te system. The value of a and k increases, while the value of n decreases with incident photon energy.

F. Shaukat, S. A. Khan, R. Farooq[3] In this paper, optical transmission measurements on different compositions of CIS films are observed and the absorption coefficient is determined. The electrical conductivity is found relatively high for the films annealed in vacuum but decreases for films synthesized optimally.

P P Pradyumnan, Swathikrishnan [7] In this paper, the preparation of p-type SnO2 doped with Fe or Cu thin films with a large thermoelectric efficiency to improve the thermoelectric effect of SnO2 doped with Fe or Cu thin film. The thermo electrical, electrical and structural properties of these films are studied using Seebeck effect measurement.

A P Rambu and N Iftimie [9] This paper introduce semitransparent amorphous selenium (a-Se) film exhibiting photovoltaic effects under UV light. It is observed that chlorine can be doped into a-Se through electrolysis of salt water and convert p-type to n-type material.

Research Gaps identified in the proposed field of investigation - Based on review

1. Development of materials with high thermo electric efficiency
2. Improving solar cell performance.

Chapter wise details of Proposed Research Investigation Ph.D. Thesis:

Scope of the Thesis –

Chapter1- INTRODUCTION

It includes the introduction to the topic of the thesis, the objective and the approach to achieve the objective.

Chapter 2- LITERATURE SURVEY

It includes the referred study material which helps in the progress of the research work.

Chapter 3- THERMOELECTRIC DEVICES

It contains the theoretical knowledge of Thermoelectric Devices, semi conductor fundamentals

Chapter 4 – DESIGN AND SIMULATION

It includes a general idea of Thermal Evaporation, SEM & TEM Microscopy, V-I characteristics

Chapter 5 –FABRICATION AND CHARECTERIZATION

It includes Fabrication of Se based thermoelectric junction and characterization of change in their properties with change in materials.

Chapter 6 – RESULT AND CONCLUSION

It contains the conclusion based on the observations and results achieved in the above chapter.

REFRENCES

It contains the list of the referred research papers and books

Expected duration of the investigation (Year wise schedule to be given):

2 Year 6 months (around)

Facilities available for the investigation at scholar end and facilities required on campus:

Vacuum coating Unit

Bibliography:

[1] R. Roy, V. S. Choudhary, M. K. Patra, A. Pandya, "Effect of annealing temperature on the electrical and optical properties of nanocrystalline selenium thin films**",** Journal of Optoelectronics and Advanced Materials, Vol. 8, No. 4, August 2006, p. 1352 – 1355

[2] A.A. Al-Ghamdi, "Optical band gap and optical constants in amorphous $Se_{96_x}Te_4Ag_x$ thin films", Science Direct Vacuum 80 (2006) 400–405

[3] S. F. Shaukat, S. A. Khan, R. Farooq, "Opto-Electrical Properties of Copper-Indium-Selenium Thin Films", Turk J Phys 31 (2007) , 265 – 269

[4] C. O. Mugah, J. Okumu and W. K. Njoroge, "Optical and Electrical Properties of SnSe Thin Films Prepared by Evaportion Method", International Research in Arts & Science, Vol. 1, No, 1, pp.019-022 November

[5] M.A. Batal, Ghassan Nashed, Fares Haj Jneed, "Conductivity and thermoelectric properties of nanostructure tin oxide thin films", Journal of the Association of Arab Universities for Basic and Applied Sciences (2014) 15, 15–20

[6] C. N. Liao, C. Chen, and K. N. Tu, "Thermoelectric characterization of Si thin films in silicon-on-insulator Wafers"**,** Journal of Applied Physics Vol. 86, NUMBER 6

[7] P P Pradyumnan, Swathikrishnan, "Thermoelectric properties of Bi_2Te_3 and Sb_2Te_3 and its bilayer Thin Films", Journal of Applied Physics Vol. 86, NUMBER 6

[8] Guvence Akgul, "Effects of thickness on electronic structure of titanium thin films", Bull. Material Sci., Vol. 37, No. 1, February 2014, pp. 41–45

[9] A P Rambu and N Iftimie, "Synthesis and characterization of thermally oxidized ZnO films", Bull. Material Sci., Vol. 37, No. 3, May 2014, pp. 441–448

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